CHAPTER 7

MISCELLANEOUS FIRES

7-1. Introduction

There are many types of fires which, though related to structural or aircraft fires, may fall into a classification different enough to warrant the use of varied specialized agents and tactics. Broadly, these fires include ammunition and explosives, motor vehicles, and natural-cover fires. To combat these successfully, the firefighter will need a wealth of knowledge about each of these categories. This chapter discusses each type of fire to only a limited extent, but the information given will provide the firefighter enough background to become more efficient as he gains experience.

7-2. Ammunition Hazards

Ammunition fires are among the most feared because of their potential destructive possibilities by detonation. Where ammunition is involved, fire prevention is doubly important, since many of the fires involving explosives and ammunition are preventable. It is the duty of fire-protection personnel and personnel handling ammunition to study the causes of fire so they will know the safety precautions which must be taken to prevent fires,

a. *Heat.* A great hazard in an around explosives is heat.

(1) Some explosives ignite at temperatures substantially lower than those required to ignite wood, paper, or fabrics. The ignition of explosives frequently results in violent reactions. Every effort must be made to maintain normal temperatures around ammunition and explosives.

(2) Fires in ammunition dump areas may be due to a number of causes. The following are moat common: dry grass, leaves, and underbrush ignited by sparks from locomotives, carelessly discarded cigarettes, campfires, or unprotected smokestacks.

b. Deterioration. Deterioration of explosives and ammunition normally occurs at such a slow rate that most of them remain serviceable for many years. Under unfavorable conditions, explosives and ammuniton which are deterioriating pick up heat so fast that it cannot be dissipated, and the explosives and ammunition may burst into flames as a result. An explosion or detonation may also result when deteriorating explosive or ammunition is confined too closely. A definite safety hazard results when repacking, renovation, and salvage operations are not properly supervised and conducted in accordance with recognized standards.

c. *Common Safety Violations.* Among the more common sources of fire hazards are excessive quantities of powder and loose explosives, accumulation of wastepaper, broken boxes, unauthorized use of spark-producing tools, defective machinery, faulty electrical equipment, and failure to provide the proper barricades and firebreaks necessary to prevent the spread of fire from one operation to another.

(1) Lack of training and violations of instructions or written regulations are frequently responsible for serious consequences. The most common violations include smoking, carrying matches in forbidden areas or buildings, and tampering with explosives or ammunition, particularly grenades or fuzes.

(2) Failure to understand and carefully observe the safety precautions prescribed for destroying ammunition and explosives might cause grass fires or explode nearby ammunition piles which are awaiting destruction. The most frequent souce of these troubles is flying fragments released upon detonation.

d. Sparks. Sparks may be created by striking iron or steel nails or metal containers against iron or steel tools, or by nails in shoes striking flint, pebbles, sand grains, or nails in the floor. Such sparks, small as they are, have caused disastrous explosions of black powder and have exploded the dust from other easily ignited powders. This hazard is the prime reason for requiring tools of brass, copper, or other non-sparking materials. It

is recommended that mud or dirt be cleaned from shoes *before* entering magazines that contain exposed explosives. Also sparks from a faulty car or truck muffler may cause an explosion.

e. *Static Electricity.* Charges of static electricity can be accumulated on a person and on explosive material such as smokeless powder. The discharge of static electricity is a serious hazard in the presence of certain exposed explosives, dust and air mixtures, and flammable vapor-air mixtures. Processing equipment for such materials subject to static discharge should be electrically grounded, benches and flooring should be covered with electrically grounded conductive material, and personnel should be provided with safety shoes of an authorized type. Cushioned metal chairs should not be used in locations where explosives or highly flammable materials are present. The failure to control safely the use of heat and flame-producing equipment offers a constant hazard.

f. Lightning. Lightning may strike buildings, trees, or other objects in or near explosive areas. Buildings and structures in storage areas should have complete lighting protection where conditions permit.

g. *Transmission Lines.* Electric transmission lines are often blown down on or come in contact with combustible material. These lines should be periodically checked for condition and security of installation. When it is necessary to install power transmission and service lines in the vicinity of the buildings containing explosives, the distance from the lines to the buildings must be greater than the distance between the poles which support the lines. This precaution is necessary to prevent falling wires from coming in contact with the building. Overhead transmission lines must not pass within 50 feet (15 meters) of the building. In future installations power lines and services which enter buildings containing explosives must be placed underground within 50 feet (15 meters) of the building.

h. Vegetation. Vegetation (such as grass, undergrowth, weeds, etc.), which is or may become a fire hazard, should be controlled by using a chemical weed killer, by mowing, plowing, cutting, livestock grazing, or, in calm weather and with the proper control, by burning.

(1) Chemical weed killers should not contain chlorates or other substances which may ignite spontaneously under hot, dry conditions or by friction.

(2) Burning should not be permitted within 50 feet (15 meters) of any earth' covered magazine containing explosives or ammunition, or within 200 feet (61 meters) of any above ground type magazine or outdoor storage pad. Brush, grass, wood, etc., gathered in piles, will not be burned within 200 feet (61 meters) of a magazine. Reserve supplies of dunnage, consisting of wood or other materials packed between explosives to prevent vibration or chafing, should not be stored hapazardly inside the magazine area. In no case may it be sotred within the 50-foot (15-meter) firebreak around the magazine.

(3) A firebreak at least 50 feet (15 meters) wide and as free as practicable from flammable material will be constantly maintained around each aboveground magazine. The earth adjacent to and extending over igloo magazines should be cleared of dry debris. Firebreaks around the entire magazine area and at other locations within the magazine area, such as along railroad tracks, must be maintained whenever necessary.

i. Trains. Locomotives, trains, and other rail vehicles used in the magazine area must be equipped so that the communication of fire will be prevented as far as [practicable. Inspections should be made regularly to insure that safe conditions are maintained.

j. Cleaning Fluids. Gasoline or other highly flammable liquids should never be used for cleaning. Solvent, dry-cleaning (Federal Specification), must be used when cleaning solvents are required.

k. Smoking. Fire prevention regulations state that matches or other flame-or spark-producing devices are not permitted in any magazine or explosive area except by written authority of the commanding officer. Smoking is prohibited in any magazine or magazine area, or in the vicinity of cars, wagons, motor trucks, or boats in which there are explosives or ammunition. Buildings or locations for smoking may be designated outside restricted areas subject to certain limitations; smoking will not be allowed in locations closer than 60 feet (18 meters) to buildings containing explosives, ammunition, or other hazardous materials.

l. Miscellaneous Hazards.

(1) When buildings close to explosive or ammunition areas are approved for smoking, windows and doors must be fitted with wire screens.

(2) Suitable receptacles must be provided for cigarette and cigar butts and pipe ashes.

(3) Only permanently installed electric lighters of approved types may be used in the building.

(4) Portable fire extinguishers, sandboxes, and water barrels with buckets must be furnished as required for each room or building in which smoking is permitted.

(6) Persons wearing clothing contaminated with explosives or other hazardous materials will not be permitted in such areas.

(6) Automobile parking should be regulated so that vehicles will not be parked within 25 feet (7.7 meters) of fire hydrants and should use designated areas only.

(7) All flashlights or storage-battery lamps used in buildings containing explosives or flammable vapors must be safety-approved types for that specific type of exposure.

(8) Ordnance safety requirements must be complied with if gasoline- or electric-powered lift trucks are used for transporting ammunition or explosives.

7-3. Preventive Measures

Occasional fires may reasonably be expected, no matter how careful personnel are with flammable materials. But, by following the principle that "an ounce of prevention is worht a pound of cure," the number of fires can be greatly reduced. Below is a brief discussion of some of the measures that can be taken.

a. ***Stacking.*** Ammunition boxes, containers, dunnage, and lumber must be stacked in an orderly manner when in the vicinity of explosives-handling or storage operations. Stacks of such combustible materials must be limited to small areas between firebreaks. Additional factors to consider in limiting the spread of fire are the available space for combustibles, the availability of fire-extinguishing facilities, and the probability of fire. Under average conditions, areas under solid stacks of such materials should be limited to 1,500 square feet (139 square meters), separated from other similar areas by 50-foot (15-meter) firebreaks in which vegetation has been cut and controlled. Bulk stacks of such materials should not be located within 500 feet (152 meters) of magazines or other buildings containing high explosives. Working quantities, within feasible limits, may be stacked in the vicinity of explosive magazines but not closer than 50 feet (15 meters). Water barrels and pails should be liberally provided in such areas for extinguishing beginning fires. Additional rules may be issued as the commanding officer deems necessary to secure the fire protection local conditions demand.

b. ***Portable Extinguishers.*** A fire involving explosives or ammunition produces a conflagration (major fire) or explosion very quickly; therefore, means for attacking the first small blaze detected are vitally important.

(1) Immediate use must be made of portable extinguishers and other hand equipment. In addition to organized permanent facilities, barrels and buckets filled with water should be placed at each magazine. This type of fire protection, when properly maintained and utilized, may 'be extremely valuable in explosive storage areas having open storage pads or combustible storage magazines. During hot weather the barrel must be refilled frequently ; in freezing weather calcium chloride or salt must be added. Buckets deteriorate rapidly unless they are frequently painted or protected from the weather. They may be blown about by windstorms if they are not securely fastened in place. Fastening devices must be easily releasable.

(2) Boxes and buckets filled with sand (with shovels located nearby) are useful in isolating, checking, or extinguishing beginning fires. To combat grass or forest fires in or near the magazine areas, an adequute supply of gunnysacks, brooms, rakes, hoes, or other similar equipment must be maintained at suitable locations. This equipment should be regularly inspected and protected against theft or unauthorized use.

(3) When explosives and ammunition are being handled, or work is being done in the immediate vicinity of such stores, two portable fire extinguishers of adequate size and rating must be ready for immediate use. It is not necessary that these extinguishers be located permanently in a magazine. Portable extinguishers must be placed in the most accessible location. Serious fires may be prevented by the prompt use of hand fire extinguishers. They are required primarily for use on beginning fires of inert combustibles, such as grass, grease, oil, dunnage, etc., which, if not extinguished, may reach explosives. Personnel other than the individual using the extinguisher should seek safety immediately and report the fire.

c. ***Water Distribution System.*** The water distribution system should be protected by sectional control valves so that damaged sections of the main can be cut off without impairing the operation of the remainder of the system. Water mains should not be located under railroads or roads used for transporting large quantities of explo-

sives or ammunition, because a detonation may break the main. When it is necessary to have water mains pass under railroads or roads, cars or trucks loaded with ammunition must not remain over these water mains longer than necessary for continuous travel. Suitable signs must be posted to indicate such a location. Water mains should be protected with cutoff valves on both sides of the railroad or road. Fire hydrants should be connected to a looped grid system to provide a supply from more than one direction.

d. Fire-Protection Personnel. The duties of firefighters, guards, military personnel, and others should be arranged so that an adequate firefighting force is available at all times.

(1) Fire drills and fire-prevention inspections should be carefully conducted to insure that firefighting forces understand their specific duties and that firefighting equipment functions dependably under actual working conditions.

(2) Fires that occur in buildings or magazines containing explosives vary in intensity and effect, depending on the material involved in the fire. Certain explosives may detonate or explode immediately on contact with a spark or flame or when subjected to frictional heat or concussion. Fire may or may not result from the detonation. Some explosive substances burn freely while others may explode while burning. Some substances develop such intense heat, as in the case of smokeless powder, that firefighting efforts are impossible. Firefighting forces should be well acquainted with the hazards and best methods of combating fires in all such materials under their protection.

(3) With certain rare exceptions, water is used as the firefighting medium. Generally speaking, for extinguishing explosive fires, large volumes of water spray or fog, produced by special nozzles with large range and volume capacities, prove more efficient than solid streams of water. Solid streams of water at higher pressures and great range should be used when consideration for the safety of firefighting personnel makes it impossible to approach the seat of the fire. Training programs should emphasize the importance of laying as many hose lines as practical in order to surround the fire completely and to extinguish it rapidly. When an explosion is imminent, firefighters must seek shelter or lie close to the ground when directing long-range water streams to the fire.

(4) Guards and watchmen should be instructed that when smoke is discovered coming from a closed magazine or when there is other evidence that the magazine is afire, the alarm must be given as quickly as possible. A single guard on duty will not enter the building, since he may become trapped and unable to give the alarm. If the fire is discovered in the grass or other combustible material surrounding the magazine, the alarm should be given immediately. The guard should then do all that is possible, using extinguishers, water from nearby water barrels, or grass firefighting tools, to extinguish or control the fire until firefighting forces arrive.

(5) When a workman or some other person discovers a fire where personnel are working and explosives are present, the personnel should be evacuated by a signal in accordance with prearranged plans. At least one responsible messenger should be dispatched in the direction from which the fire department is expected in order to inform them of the nature and extent of the fire. The officer in charge of firefighters must not permit the advance of his men to such a fire unless he has what he believes to be accurate information as to the existing conditions and concludes therefrom that he is justified in so doing.

(6) Firefighting forces should attack a grass fire vigorously and try to extinguish it even when it is burning in the vicinity of a magazine. If a fire has actually gained headway in a magazine, firefighting forces should either combat the fire or seek the nearest suitable protection, depending on the type of ammunition or explosives within the magazine.

NOTE

When a fire occurs in a locked magazine, no attempt will be made to enter the magazine or fight the fire. All personnel will evacuate the area to a safe distance.

74. Kinds of Explosive Fires

To guide firefighting organizations, explosives are divided into four groups in accordance with the general burning or explosive characteristics of the materials and the relative danger in fighting fires in which they are present. The four groups are identified by the symbol numbers 1 through 4 (fig. 7–1); as the hazards to firefighters increase, a progressively larger number is used. Regulations

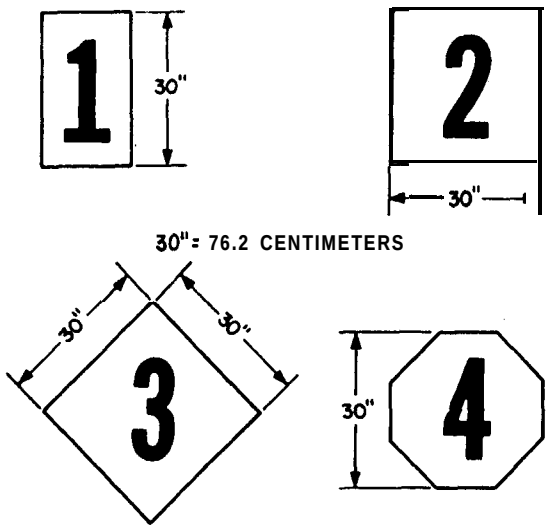


Figure 7-1. Hazard markers (fire symbols),

require that buildings containing hazardous or explosive materials, except igloo magazines, be plainly marked with the symbol number of the most hazardous material contained therein. These numbers must be at least 24 inches (61 centimeters) high, 20 inches (51 centimeters) wide, black lettering on yellow background.

a. ***Ammunition Storage Chart.*** In the early days of explosive manufacture, black powder was the only explosive used. Later, more sensitive explosives were manufactured. Still later, chemical ammunition came into use, and serious explosions occurred because of carelessness in handling. The ammunition storage chart was devised to standardize the handling of ammunition and to prevent accidents. This chart separates ammunition into the ammunition hazard classes shown below. These explosives and ammunitions must not be stored together in any random combination. They are mixed only under certain specific conditions which permit a maximum degree of safety.

Class l-small-arms ammunition and similar items
Class 2—smokeless powder and other fire hazard items
Class 2A—items similar to Class 2, but presenting a detonation hazard
Class 3—point detonating fuzes and similar items
Class 4—small high-explosive (HE) cartirdges and mines
Class 5—larger caliber HE cartridges
Class 6—separate loading HE projectiles
Class 7—mass-detonating high explosives
Class 8—chemical hazard without explosives

(1) *Symbol* 1. The symbol 1 group of explosives consists of class 1 ammunition.

(a) These are metallic powders in approved shipping containers-chlorates, perchlorates, peroxides, nitrates, and other inorganic oxidizing agents in sealed containers. While these materials are principally fire hazards, and fires in which they are involved may be combated, minor explosions may also be expected. Described below are some of the characteristics of fires in this group and the safety measures prescribed for them,

(*b*) Shipping containers of small-arms ammunition, especially when incendiary and tracer rounds are included, will continue to burn intensely even after the magazine has been consumed. Personnel attempting to fight the fire after it has reached the ammunition must be shielded from missiles, which may be expected to travel up to ZOO yards (183 meters) at a velocity of 200 feet (61 meters) per second. Sheet-metal-covered wooden shields can be used and moved to various vantage points. When it is practicable to use waterfog, it is found to be very effective for extinguishing such fires.

(*c*) Oxidizing agents are not flammable in themselves, but when heated in a fire involving combustibles they liberate oxygen, which greatly facilitates the burning. Suitable masks should be provided to guard against the poisonous fumes resulting from such fires. Cooling or "drowning" with large quantities of water may control or extinguish these fires. After the fire has gained considerable headway, firefighters must direct their efforts to protecting adjacent property.

(d) For fires involving chemical ammunition containing blister agents, firefighters must be protected by masks and complete protective clothing. If possible, such fires should be fought from the windward side. All unprotected personnel downwind must be evacuated and civilian inhabitants should be warned. Fires involving toxic chemicals should be fought with similar precautions except that the downwind area will be less hazardous. In fires involving hazardous chemical (H) smoke mixture, attempts should be made to remove and segregate the burning containers. When a relatively small amount of HC smoke mixture is involved in a fire, it may be saturated with water. Water will also serve to cool adjacent containers to prevent further propagation. Unless water can be applied in large amounts in relation to the actual HC smoke mixture exposed and burning, the efforts to light the fire will be inef-

fective, and the material may explode. Firefighters should not enter magazines containing a high concentration of HC smoke unless adequately protected by oxygen masks and supplied with lifelines.

(2) *Symbol 2.* The symbol 2 group consists of Class 3 ammunition and explosives. Personnel discovering such a fire should first give the alarm and then attempt to put the fire out with the equipment on hand, provided the fire is in the beginning stage. The firefighting organization should fight the fire if there is a possibility of extinguishing it. If extinguishment does not appear possible, the building should be abandoned and the firefighting efforts concentrated on preventing spreading. Limited explosions may be expected from fire in these materials. Personnel should be careful to prevent injury to themselves and damage to their equipment.

(3) *Symbol 3.* The symbol 3 group consists of Class 2 and Class 2A material.

(*a*) Unless the fire is minor and does not involve the explosive itself, and there is a chance of controlling it, firefighting should be confined to preventing the spread of the fire to other buildings. These materials burn with intense heat, and personnel and firefighting equipment should be adequately protected.

(b) When fires involve phosphorus, personnel entering magazines with portable extinguishers must have lifelines attached to themselves to enable them to find their way out through the heavy smoke. It should be remembered that phosphorus will stop burning only so long as it is under water; when exposed again to the air, it ignites spontaneously.

(c) Fires involving pyrotechnics and large quantities of magnesium type incendiaries make it necessary for firefighters to confine their efforts to protecting adjacent buildings and magazines. Water may accelerate burning and cause explosions which will scatter burning material. The use of carbon dioxide may cause a suffocating atmosphere. Small fires involving 50 pounds (22.7 kilograms) or less of magnesium can be smothered with dry inert material, powdered or granular, such as hard coal, tar, pitch, graphite (preferably coated to eliminate dust), rustfree cast-iron borings, soft coal, talc, salt, or sand. Asbestos, sand, salt, and talc are not inert in magnesium fires, but may be used dry if the fire is small. The powder from these agents should be placed over the burning material to cover it at least 1 inch (2.54 centimeters) deep. It should not be disturbed until the magnesium has cooled, excpet when the fire is on a floor of flammable material. In this case, after the fire is covered, a 2-inch (5-centimeter) layer of extinguishing powder should be placed on the floor beside the fire and the burning material raked onto the insulating layer and resmothered.

(4) *Symbol 4.* The symbol 4 group includes Classes 4, 5, 6, and 7 ammunition and explosives.

(*a*) Every effort should be made to prevent fire from reaching these classes of material, which are especially hazardous. If a fire occurs in a magazine containing these materials, personnel present should attempt to extinguish the fire with the equipment at hand, providing the fire has not actually reached the material and there is a favorable chance of extinguishment. If the fire appears beyond control, personnel must evacuate the magazine and take cover. If fire breaks out in a magazine containing high explosives, firefighting forces will not immediately approach the fire.

(b) Unless specific information is available (either from one who was present when the fire was discovered or from intimate knowledge of the construction of the building and location of the explosives) indicating that it is safe to approach the fire, firefighting forces will remain in a position 1,000 feet (305 meters) away from a fire involving up to 50,000 pounds (22,680 kilograms) of high explosives until the explosions have occurred. A proportionally greater distance is required for larger amounts of high explosives (up to 2,000 feet (‘710 meters) for 100,000 pounds (45,360 kilograms) of high explosives). Firefighting forces and their equipment must not be exposed to unnecessary risk when these materials are involved. Demolition or general-purpose ‘bombs and antitank mines can detonate en masse, and propelling charges may explode, producing heat capable of blistering the paint on buildings 500 feet (152.5 meters) away. Bulk high explosives packed in boxes will usually burn quietly but may also detonate. Black powder, photoflash bombs, smokeless powder in bulk, and unpacked propelling charges explode or flash so quickly that little time is left to do anything to save the magazine involved. In almost every instance, the efforts of firefighters will be confined to preventing fire from spreading to adjacent buildings or magazines.

b. Summary of Explosive Fires. Fire is, without question, the principal hazard in the storage of ammunition in the field.

(1) The fact that ammunition and explosives are capable of such violent destructive force when exposed to heat makes it extremely important for fire-protection personnel to become as completely familiar as possible with the characteristics of various explosives and ammunition when they are exposed to heat. The men in charge of firefighting crews should be well aware of the importance of the counsel of ordnance specialists before and during an emergency.

(2) The ammunition officer must be completely familiar with the local environment of the areas in which ammunition and explosives are stored. He should also know the characteristic reactions of materiel to fire. The opinion of the ammunition officer, therefore, before and during the combating of the fire, should be respected. If the order is given to remain at a safe distance in readiness to prevent further fire spread after detonations or to withdraw men during the combating of a fire in expectation of an explosion, the action should be taken immediately. Where ammunition and explosives are present and where these' conditions exist, an ounce of prevention is worth a ton of extinguishment.

7–5. Chemical Munitions Markers

Hazard markers provide a guide for firefighters and other personnel by indicating the chemical group of stored chemicals. The markers are yellow disks with a diameter of 24 inches (61 centimeters). Figures 7–2 through 7–8 show the symbol for each of group A, B, C, D, and nerve agents. Each figure also states what the symbol indicates and the hazard of the chemical agent or the precaution to be taken.

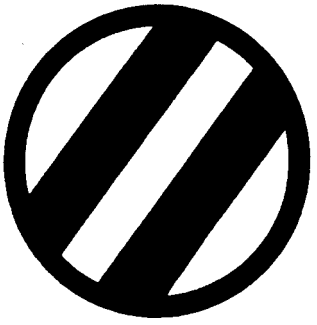
7-6. Motor Vehicle Fires

Another type of firefighting is fire resulting from motor-vehicle accidents.

a. These accidents are responsible for many thousands of deaths annually. Many of these deaths and many serious injuries are caused by victims being trapped in wreckage that has caught fire. This danger is always present in the Army because of the large volume of motor-vehicle transportation required.

b. Of course, motor-vehicle accidents are often attributable only to negligence or recklessness,

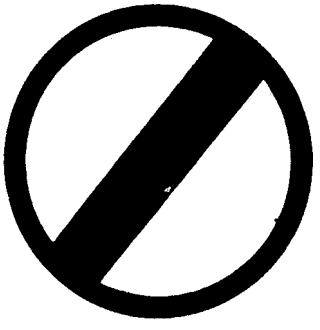
Yellow disk witb 2 parallel black bands



INDICATES	PRECAUTION
Group A (except nerve agents).	Wear complete protective clothing and protective mask, Work upwind.

Figure 7–2. **Hazard** *marker for group A.*

Yellow disk with diagonal black band



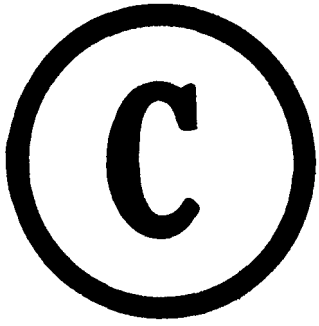
INDICATES	PRECAUTION
Group B toxic chemical agents, nonburning screening smokes, and nonburning mixtures of riot control agents.	Use protective mask. Wak upwind. Enter with care.

Figure 7–3. Hazard marker for group B (except BZ) .

Yellow disk witb black letter **Z**

INDICATES	PRECAUTION
Special chemical hazard. Incapacitating agent BZ.	**Use protective mask. Work upwind. Enter with care.**

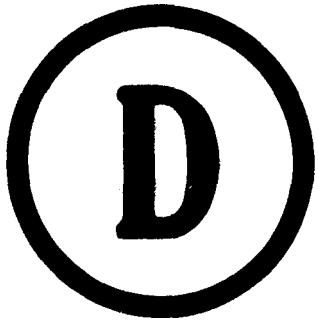
Figure 7-4. Hazard marker for agent BZ.



Yellow disk witb black letter **C**

INDICATES	HAZARD
Group C spontaneously flammable chemical agents.	**Dangerous *to* enterwithout life-line and protective mask.**

Figure 7-5. Hazard marked for group C.



Yellow disk witb black letter D

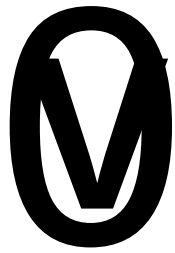
INDICATES	HAZARD
Group D incendiary and readily flammable chemical agents.	**Intense radiant heat. Danger of explosion if water is used to attempt to extinguish fire.**

Figure 7-6. Hazard marker for group D.

Yellow disk witb black letter **G**

INDICATES	PRECAUTION
Special chemical hazard. G-type nerve agents.	**Wear complete protective clothing and protective mask. Do not enter until clearance is granted.**

Figure 7-7. Hazard marker for G-type nerve agents.



Yellow dish **witb** *black letter V*

INDICATES	PRECAUTION
Special chemical **hazard. V-type nerve** I @ o t s.	**Wear** complete **protective** clothing and protective **mask. Do not enter until** clearance is **granted.**

Figure 7-8. Hazard marker for V-type nerve agents.

but when large numbers of personnel and quantities of materiel are transported under even the most favorable conditions, some mishaps are unavoidable. It is the duty and responsibility of **fire**-protection personnel to prevent loss of lives and property as a result of motor-vehicle accidents and, resulting fires.

c. When a motor vehicle overturns, or when it crashes into another vehicle or object, **trapping** the occupants inside it, assistance by experienced rescue personnel becomes an immediate necessity to prevent death by injury or fire.

d. Basically, motor-vehicle fire safety depends on **four** conditions: design and construction features ; use of the vehicle, including its garaging ; **proper** repair and maintenance ; and operational safety procedures.

e. 'The use of all-steel bodies has resulted in increased safety, both from the accident and the fire-hazard standpoint. Interior finishes, however, particularly upholstery and linings, still remain a definite fire hazard unless these **fabrics** are treated with a fire retardant.

f. The fuel-tank's construction, location, and security, and its vulnerability to damage in a collision or upset, are the most important **features** of design for fire safety. The use of seat tanks and cowl tanks has largely disappeared. Fuel tanks are safely located at the rear of, or beneath, the vehicle, in a position where they are not **inclosed** in the body. This positioning of the tanks gives passengers a better chance to escape if the auto catches fire. Trucks normally have tanks of **12-gage** steel, having high resistance to rupture. These tanks are of double thickness at the edges, will not spill fuel in an upset, contain an automatic pressure relief in the event of exposure to fire, will not seep gasoline, and cannot be overfilled. Vibration, corrosion, and improper maintenance are some of the chief factors responsible for fuel-system failures, particularly at fuel-pump fittings, tubing, filters, and carburetors.

g. The fire safety factor in the electrical system of automobiles lies primarily in proper installation, fusing, and maintenance. Fires of an electrical origin are normally propagated by petroleum deposits in the engine area or by combustible materials, such as fabric lining. In a collision or upset, electrical short circuits are likely to occur unless an automatic overturn switch cuts the electrical power at the battery. Proper installation of exhaust systems is important, as incandescent carbon particles and hot exhaust gases may ignite flammable liquids, grease, and other combustible materials. Brakes are a possible fire hazard because their overheating may cause the ignition of oil, grease, or brake fluid. Friction heat frequently may **cause** underinflated tires to ignite. Antifreeze-alcohol vapors are an added fire hazard, as are certain types of heaters.

h. In motor-vehicle fires, the first task is to evacuate all persons from the vehicle. If the fire is well advanced, fire-control operations may be necessary before they can be rescued. As soon as entry is made and personnel are removed from the vehicle, the ignition switch should be turned off, if this has not already been done. The battery should be disconnected (remove ground cable first) as soon as possible to prevent reignition of the already heated fuel vapors.

i. The average motor-vehicle fire can be quickly extinguished with portable CO_2, $CF3Br$, or dry chemical extinguishers. When the engine area is involved in fire, the extinguishing agent can be applied through the louvers on grill. This permits extinguishing the fire without opening the hood.

Leaving the hood closed limits the oxygen and allows the extinguishing agent to work in a more confined area.

j. When the fire originates from a fuel tank leak, the fire closest to the tank should be extinguished first. The outlet in the tank then should be plugged to stop the flow of fuel. If the fire is in the upholstery, the area should be saturated thoroughly with water until every spark is eliminated. When a tire catches fire because of underinflation, large quantities of water are needed to extinguish the fire and prevent it from spreading.

k. The procedures in attacking a motor-vehicle fire will be described in proper sequence and detail in this and the following subparagraphs. The approach and general estimate of the fire must be considered first. Even as they approach the vehicle, the firefighters must be alert to protect or rescue personnel in or near the accident. Firefighters must be aware of the fact that victims with clothing on fire may run some distance from the scene of the fire. It is also possible that persons may be thrown from the wreckage and left unconscious near the scene where they are in danger of being run over by fire-department vehicles.

l. The primary consideration of the fire crew is to place the fire apparatus in a location which will enable the crew to give occupants the most complete protection and to control the fire so that personnel may be rescued with a minimum of delay.

m. The fire should be controlled first in the immediate area of the vehicle to relieve the occupants of excessive heat. No attempt should be made to extinguish the fire completely at the onset unless it is certain that no persons are still within the burning wreckage. Personnel rescue should be given priority because a difference of seconds may determine the life or death of a victim. Also, the extent of the fire may be too great for the quantity of extinguishing agents available in the firefighting apparatus to extinguish the fire completely.

n. When necessary, forcible entry must be made where it offers the most expedient access to the interior and is at the same time consistent with the location of trapped personnel within the vehicle. The person or persons closest to the point of entry should be rescued first. During rescue, the victims must be examined as thoroughly as time permits; the extent of injuries will be considered, and first aid will be administered *at* once. A visual check of the victim should be made before or during rescue. If bleeding is profuse, direct pressure should be applied to the wound even before the rescue is completed. Rescued personnel should be moved to a safe spot quickly and carefully.

o. Firefighters must extinguish the flames in the area where the source of gasoline flow can be stopped. While cutting off the flow of gasoline, or while in the presence of gasoline vapors, the crewmen must always be alert for the signal which warns of the near depletion of extinguishing agents. This is a signal given by the pump operator for withdrawal of personnel. It consists of intermittent blasts from the fire vehicle. The pump operator is responsible for observing the consumption of the extinguishing agent.

p. After the gasoline supply has been shut off, the fire is immediately extinguished and the entire area is cooled to prevent reignition. The overhaul operation consists of entering the vehicle and thoroughly extinguishing every existent spark. If the fire was extinguished with CF3Br, the motor vehicle should be thoroughly ventilated before anybody enters it. The immediate area in which fire occurred also requires close observation, complete extinguishment, and reinspection.

q. During overhaul, each crewman should be alert for any evidence which will aid in the investigation to determine the cause of the fire. These "after-extinguishment" procedures require that a charged hose line be immediately available in the event of a sudden reflash.

7-7. Special Nozzles and Equipment

The majority of emergencies that the structural firefighter will have to face can be dealt with successfully by using the tools and equipment that have been explained in previous chapters of this manual. 'The fighting of special types of fires, such as those covered in this chapter, requires the use of specialized equipment, particularly nozzles.

a. *Fog Nozzle.* The ideal fog nozzle (para 2–9*a*) can discharge either fog or a straight blasting stream. After the high-velocity fog tip has been removed, it is possible to insert any one of several variable-length applicators containing a nozzle which discharges a low-velocity fog. This nozzle change will not require a change in nozzle pressure. Either the high- or low-velocity fog may be used for personnel protection or for extinguishing the fire, depending upon wind conditions and accessibility. Generally, the low-velocity fog is preferable when extinguishing a fire from the windward side and where large open surface

areas are involved. A leeward-side fire requires the use of high-velocity fog for personnel protection and penetration. Fog nozzles are made for use with both the 1½-inch (3.8-centimeter) and 2½-inch (6.35centimeter) hose. The high-velocity fog tip and the low-velocity applicator may be inserted or detached in seconds.

b. *Foam Nozzle.* The mechanical foam nozzle tor consists of a metal base through which the consists of a venturi (cap v) system installed in an aspirator cage near the rear of the nozzle. A pickup tube is installed near the aspirator cage. The venturi system creates a partial vacuum, which enables the foam to pass through the tube from a foam can. The aspirator cage is responsible for injecting the proper amount of air into the proportionately mixed foam solution.

c. *Foam Generator.* The chemical foam generator consists of a metal base through which the water passes. The base includes a male and female coupling, normally 2½-inch (6.35-centimeter) size; a venturi; a gage; and a valve. Mounted on top of the base center is the tapered metal hopper into which the powder is poured. The water passing through the venturi system "pulls" the powder into the water stream in the proper proportions, after which the powder and water are turbulated through 50 to 150 feet (15 to 46 meters) of 2½-inch (6.35-centimeter) hose to the nozzle. When the water makes contact with the powder, a chemical reaction takes place which results in expansion, causing additional pressure and affording considerable range from the nozzle.

7–8. Natural Cover Fires

Natural-cover fires involve grass, weeds, grain, brush, forest, or any other plant life.

a. Forest fires are no doubt the most serious of all natural-cover fires from the standpoint of a national fire problem. Forest fires involve more than the immediate monetary loss. The cost is insignificant compared with the effect on the future water supply and timber supply, and with the loss of hunting, fishing, and recreational facilities, to say nothing of the loss of life which may occur. (A single forest fire in Minnesota is known to have taken 559 lives, a fact which emphasizes the importance of organized fire safety before such catastrophes occur.)

b. Forest fires frequently involve farms, villages, and towns. For this reason, fire-protection organizations are called upon to handle both structural and natural-cover fires. During recent years, the nation has become increasingly conscious of the importance of the prevention and control of fires in camps and buildings, for these may expand to become forest fires.

c. The majority of natural-cover fires are caused by man and are the result of carelessness, The natural elements, such as lightning, the sun, and the wind, are responsible for the remainder. Careless hunter, campers, and fishermen, and frequently local residents, account for more fires than any other causes. Other causes of forest fires include locomotives, burning of rubbish, lumber operations, and arson. The most effective means of combating these fires should be started before the fire actually occurs-through the medium of law enforcement, restrictions, education, and the complete elimination of hazards in critical areas.

d. Prompt discovery of forest fires is essential in achieving quick control and limiting damage. In areas where efficient detection, control, and fire-extinguishing organizations are present, fires rarely get out of control and damage is kept to a minimum. The methods of detection include ground and air patrols and forest observation towers.

e. An adequate system of trails and roads, properly distributed, built, and maintained throughout the area, is of utmost importance in making the fire area reasonably accessible to fire-fighting forces and their equipment. Roads of proper width are also invaluable as firebreaks, which prevent the spread of fire beyond a limited area. In many instances, it is necessary to clear strips for permanent firebreaks,

f. Aircraft of various types are now being successfully used to transport men and supplies to the scene of forest fires, especially such areas as may lack trails and roads. Parachute-jumping fire-fighters started extensive training before World War II, and have expanded and improved their effectiveness consistently during each succeeding year. In the years following the war, considerable experimentation and test flying was performed by the Air Force. The use of helicopters has been very effective. For forest-fire extinguishing by aircraft, the "water bomb" and other airborne devices are now being tested for effectiveness.

g. Training and organization are essential to suppress forest fires successfully. Under extensive emergency conditions, it is frequently necessary to use all able-bodied personnel within an area. At

such times, it is highly important to have well-trained men available to organize and supervise the untrained force. The complete and extensive training of fireguards and lookout men is of utmost importance.

h. The equipment used must be adequate and suited to the immediate environment. This implies, for example, that large vehicles will not be employed where roads are narrow and where there are small bridges with limited capacity. Areas where the water supply from ponds, lakes, and small streams is plentiful might advantageously employ several portable pumping units, but these units would be almost useless where water is scarce. In some areas, water cans equipped with a hand pump are carried on the backs of personnel. For fires in logging woods, water tanks mounted on pump-equipped trucks are commonly used, as are railroad tank cars.

7-9. Tools

a. The common portable pump weights about 75 pounds (35 kilograms). It is gasoline driven and can deliver 60 gallons of water per minute through a 1½-inch (3.8-centimeter) hose at 100 pounds of pressure per square inch (7 kilograms per square centimeter). To attain this output, a ⅝-inch (1.6-centimeter) nozzle tip should be used. The hose may be rubber lined, canvas covered, or it may be linen for lightness. Frequently, these portable pumps are hooked up in series to enable propulsion of water over great distances or up mountainsides.

b. Power-driven tools and equipment are available for natural-cover firefighting in a wide variety of designs and sizes. Power-driven equipment is used primarily for constructing barriers or firebreaks. Such equipment varies from 100-pound (45-kilogram) trenchers to 10-ton (g-metric ton) tractors with front-mounted, power-controlled angle blades. These large tractors are better than all other equipment for fireline construction through heavy forests but costly equipment is required to move them to the desired location. Lightweight tractors are now being developed for fast initial attack.

7-10. The Nature of Natural-Cover Fires

Natural-cover fires can move very rapidly, especially when the wind velocity is high. The perimeter, or fireline, is the hottest part of the fire. The interior of the fire is a smoldering mass with comparatively fewer flames and with many glowing embers or sparks. Natural-cover fires are best controlled along the fireline.

ct. *Parts of the Fire.*

(1) The point where the fireline is progressing fastest is called the *head*. A natural-cover fire may have any number of heads, depending on the type, abundance, and location of the fuel. Fire heads generally travel with the wind; the stronger the wind, the greater the speed of the fire. Because of frequent directional changes of the wind, varying types and quantities of fuel, and topographic conditions, natural-cover fires have irregular perimeters, making control difficult and often dangerous. The upwind or windward portion of the fire is called the *tail*. Usually the tail is in or near the general vicinity of the origin of the fire.

(2) All portions of the fireline between the tail and the various heads and those slower burning areas between the heads are called *flanks*.

(3) The rate of burning of natural-cover fires depends primarily on the velocity of the wind, type and abundance of fuel, and general topographic conditions. The head of the fire travels at a rate proportional to the wind velocity. Wind carries additional oxygen to the fire and increases the rate of burning. The hot air rising from the fire causes a partial vacuum. Cold air with a fresh supply of oxygen rushes in at the base. The larger and hotter the fire, the stronger is this draft created by the fire.

(4) Fire heads move faster uphill and through draws or canyons than on level ground or downhill, other conditions remaining equal. Heads burning uphill dry out and varporize fuel faster than those burning on level ground or downhill. The upward rush of cold air acts like the draft in a chimney and speeds burning accordingly. Heads running up draws, valleys, or canyons cause the inrush of cold air with a new oxygen supply to be concentrated in a small area and, as a result, the fire propagation rate is greatly increased. This condition is similar to a forced draft in a blacksmith% forge, fanning the fire to a greater speed and intensity. Men or equipment should never approach the head of a fire from upwind when the approach necessitates travel in a draw, valley, or canyon.

(5) A running fire should never be controlled from the uphill direction. This entails a high risk to men and equipment. The correct point to begin control is at the tail on the upwind side of the fire line or at the head of the fire when it tops a crest